

# Vulnerability to Climate Change in California

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# Physical vulnerabilities

- Long coastline – flooding, wetlands, beaches.
- Water supply
  - Complex systems required to match location & timing of precipitation with location & timing of use, vulnerable to disruption
  - Depends crucially on the snowpack for 1/3 of storage
- SF Estuary/Delta – inland flooding, water supply, ecosystem all vulnerable.
- Agriculture & forestry, directly exposed to the weather, are important economic sectors.
- Energy supply capacity, especially peak power for air conditioning
- Health – air quality, ozone, asthma etc

# Institutional vulnerabilities

- Our institutional vulnerability is probably greater than our physical vulnerability
  - Water
  - Land use planning
  - Flood control financing

# Prerequisites for adaptation in water

- Monitoring and measurement
  - To establish a baseline of resource use etc
  - To measure pace of change
- Adequate ability of property rights and other institutions to accommodate consequences of climate change
- Effective governance mechanism for collective action
  - To undertake public (as opposed to private) adaptations
- In all of these, California is lacking.

# Measurement

- In California, we do not measure or monitor surface water diversions by most non-project users.
  - This undermines our theoretical appropriative rights system of water allocation.
  - An informal (local) system of water allocation without measurement may work fine with the status quo, but it can be highly counterproductive in the event of a change in climate regime.
- We also have not firmly quantified many surface water rights
  - If we don't know who is using how much, and we don't have a good baseline of water rights, how will we manage the change in stream flow?

# Groundwater

- In many areas of California, surface water users also have access to groundwater, and will increase groundwater pumping as an adaptation to reduced surface water availability.
- Conjunctive use – storing surface water in aquifers – is in principle an attractive alternative to above ground storage.
- California is the only state in the American West which does not regulate or measure groundwater extraction.

- Our failure to measure how water is being used in California, *at the user level*, is an invitation for a train wreck.

# Economics of adaptive response

- What distinguishes the real world from the simple economic theory of adaptation is:
  - There is not a single actor but multiple actors. Most adaptation is local.
  - Adaptive action is mediated by institutions which govern the allocation of costs and benefits and the pace of decision making.
  - The facts of climate change and potential adaptations are not known with certainty, nor are they agreed to by the parties involved.
- These influence both the timing and the nature of the actions that occur.



# The timing of adaptation

- Before an action can occur, an agent has to perceive a reason for undertaking the action.
- This underscores two potential obstacles to timely or effective adaptation: the lack of perception of a need for action, and the lack of perception of a benefit from the action.
- Whether and when a problem is perceived by a decision maker is likely to vary.
- The result is that errors in the timing of action – judged with hindsight – are likely to occur. The errors can be in either direction: too hasty or too tardy.

- There are many examples from history where problems were recognized too late; for example, where preventive action against wildfire was undertaken only after a serious wildfire had occurred (San Diego County, California).
- Similar examples exist for both flood and drought prevention.

# How quickly is adaptation implemented? Hurricane Katrina

- In 1955, USACE starts planning for flood protection in New Orleans.
- In 1962, USACE completes comprehensive flood protection plan. No action is taken.
- 7 weeks after Hurricane Betsy in 1965, Congress authorizes construction of New Orleans Flood Defense System at cost of \$80 million and with completion date of 1978.
- When Katrina hit in 2005, the cost was over \$700 million and the projected completion date was 2013, with likelihood of further postponement.
- The two portions of the flood defense system that failed most comprehensively when Katrina hit were officially rated as 90% and 98% complete.

# What are the lessons of Katrina?

- Katrina is not at all unrepresentative as an example of flood defense by the federal government through the USACE.
- Clearly, though, it is not necessarily representative of efforts by all organizations, private and public, everywhere in the world, to deal with sea level rise.
- Nevertheless there are some features of the New Orleans/ Katrina experience which may have some general applicability.

- What is involved here is infrastructure that is generally supplied by governments.
- The costs of this type of infrastructure are mainly fixed costs, not variable costs.
- The infrastructure has to be built all at once – you can't finance it incrementally as more is used.
- Moreover, this type of infrastructure is (or is intended to be) relatively long-lived. Once built, the levees were expected to last for decades, even perhaps a century or more.
- Much of their lifetime benefit will go to future generations, but it is not possible to make those generations contribute to the up-front cost of building the levees now.
- Therefore, one naturally turns to the government to finance this infrastructure in the public interest.

- In short, this is very capital-intensive and long-lived infrastructure, heavily reliant on the public sector for its provision, and involving multi-jurisdictional participation and multi-jurisdictional conflicts.
- Wherever this constellation of factors occurs, it is likely to delay the implementation of adaptation and, perhaps also, impair its efficacy.
  - Lack of funds causes government to stretch out project completion
  - Inter-jurisdictional conflict slows project down

# Distribution and adaptation

- Distributional issues associated with adaptation, create difficulties for its financing.
- The question is whether affairs can be arranged so that the people who benefit from the adaptation are the ones who pay for it, and conversely. This may not happen automatically.
- Adaptation is often likely to involve significant distributional issues partly because climate change itself is often a major agent of re-distribution (some areas, sectors, occupations lose, while others gain).

- When defending against sea level rise, because of the high cost it is likely that a decision will be made to abandon *some* of the land threatened by inundation rather than protect every last inch. But this imposes a loss on the owners of the unprotected land and they will oppose the defense system unless they are compensated.
- Poor people often may be more vulnerable to climate impacts than the rich; will they therefore be expected to pay more?



- In the real world distributional issues are highly important factors determining which actions are undertaken and which policies actually get implemented.
- Ignoring the distributional implications of adaptation is likely to lead to an over-optimistic assessment of how much adaptation occurs, and how quickly.
- Unless and until the distributional issues are resolved, adaptation will be stymied.

# Adaptation & institutional reform

- There certainly will be autonomous, private efforts at adaptation.
- But there are some key issues:
  - Co-ordination of adaptation
  - Dealing with public infrastructure
  - Providing of insurance
- Governments are likely to have a key role here: by themselves markets may not be adequate.

- Dysfunctional institutional structure – fragmentation, incoherence, conflict – is an impediment to adaptation.
  - In the US, we don't do land use planning.
  - Land use, water supply, fire control, public health, etc are highly decentralized
- All the more reason to highlight Institutional reform – getting our house in order – as a precondition for effective adaptation.
- It is said that many adaptations are win-win actions we should undertake anyway. But, the fact that we have *not* undertaken them already is grounds for some pessimism: it suggests there are systemic obstacles which may be hard to overcome.